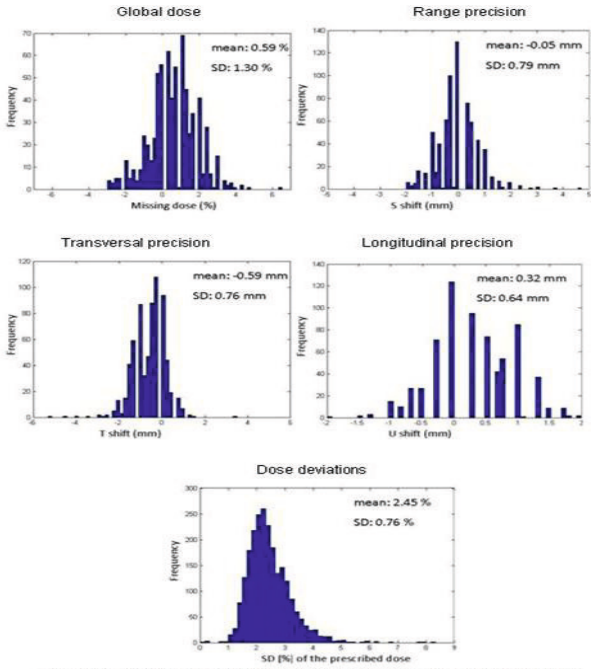

Figure 1: Summary of the dose and spatial precision of all field specific verifications 2007-2012

Conclusions

Over a long period, our proton therapy facility has been reliable and accurate in its delivery. As the correctness of each steering file is anyway independently checked by a dose calculation based directly on the content of the steering file, we are therefore proposing to move to a new QA strategy. This will consist of weekly dosimetric verifications of only a standard and quasi-randomly selected field, to ensure consistency in the performance of the proton facility. This policy will improve workflow issues caused by the obligatory field-by-field verification adopted up to now.

PROFFERED PAPERS: RTT 2: GEOMETRIC UNCERTAINTIES: MOTION MANAGEMENT

OC-0161

Simulations of the effects of organ motion on target coverage in proton therapy of prostate cancer

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Purpose/Objective: During radiotherapy of the prostate, inter- and intra-fractional organ motion can cause deviations in prostate location of more than 10 mm away from the position assumed during the planning stage. This can potentially degrade the dose target coverage. In this treatment planning study we have investigated the impact on target coverage caused by organ motion when treating prostate cancer with protons, with an emphasis on the situation when particularly tight margins are applied. The dosimetric effects were compared for two the techniques Intensity Modulated Proton Therapy (IMPT) and passive proton Double Scattering (DS).

Materials and Methods: CT scans of 8 prostate cancer patients were re-planned with IMPT and DS using the Eclipse Treatment Planning system (Varian Medical Systems). The prostate was defined as the Clinical Target Volume (CTV) and was expanded isotropically with 2 mm to define the Planning Target Volume (PTV). The total prescribed dose to the PTV was 76 GyRBE and the evaluation was based on 95 % target dose coverage of the PTV in addition to normal tissue dose constraints. Both the IMPT and DS treatment plans consisted of two opposing lateral fields. To simulate prostate organ motion, the CTV was shifted 6 mm and 12 mm in posterior/anterior, superior/inferior and lateral directions, and plans were re-calculated for each shift with the original field and plan parameters.

Results: CTV shifts in all directions caused degradation in target coverage, however, the degradations differed considerably between the two treatment techniques. For the 6 mm shifts in the anterior direction the mean dose coverage across all patients was reduced to 88 ± 2 % with DS and was additionally decreased to 81 ± 4 % with IMPT. Similar trends were seen also for the posterior as well as the superior/inferior directions (Table 1). For the lateral shifts an opposite effect was found, with slightly larger dose reduction for DS compared to IMPT. The effects for 12 mm shifts were enlarged, with larger degradations for the anterior/posterior and superior/inferior directions with IMPT (Figure 1), but smaller for lateral shifts.

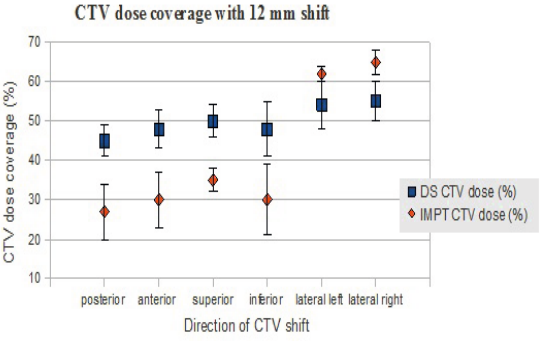

Figure 1: Mean CTV dose coverage in 8 patients resulting from 12 mm shifts in the position of the prostate target volume. A decrease from 95% dose coverage in the plans with no shift.

CTV dose coverage with 6 mm and 12 mm shifts

	Dose coverage 6 mm shift (%)		Dose coverage 12 mm shift (%)	
	DS	IMPT	DS	IMPT
posterior	88 ± 2	79 ± 6	45 ± 4	27 ± 7
anterior	88 ± 2	81 ± 4	48 ± 5	30 ± 7
superior	88 ± 4	83 ± 2	50 ± 4	35 ± 3
inferior	87 ± 3	80 ± 5	48 ± 7	30 ± 9
lateral left	84 ± 6	90 ± 2	54 ± 6	62 ± 2
lateral right	85 ± 3	91 ± 2	55 ± 5	65 ± 3

Table 1: Mean CTV dose coverage in 8 patients resulting from 6 mm and 12 mm shifts in the position of the prostate target volume. The original plans with no CTV shifts achieved 95% dose coverage in both techniques DS and IMPT.

Conclusions: In this study we have shown that prostate motion can cause severe reduction in target coverage. The degradations appear to have a higher impact when treating with IMPT than with passive DS.

OC-0162

An evaluation of VMAT and IMRT intrafraction motion in NSCLC patients treated with SABR

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Purpose/Objective: Although Stereotactic Ablative Body Radiotherapy (SABR) has become the standard treatment for T1-T2 inoperable non-small cell lung cancer (NSCLC), the manner in which this is delivered may differ between institutes. Often coplanar and non-coplanar IMRT with 10 or more beams is performed, resulting in long treatment times. Image guidance, imperative for SABR increases this time even further, while intrafraction motion has been found to correlate with the overall treatment time[1]. Since the introduction of volumetric modulated arc therapy (VMAT), treatment times have been considerably reduced. This study aims to evaluate intrafraction motion in NSCLC patients treated with IMRT and VMAT based SABR.

Materials and Methods: NSCLC patients treated with SABR(3x18 Gy) were consecutively selected from our database; 100 IMRT and 50 VMAT. All patients were treated using a frameless technique whereby patients were positioned on a mattress with arm and knee support. The image guidance protocol for both techniques was identical: 1) a 1st CBCT was acquired prior to each fraction that was registered using a dual registration algorithm on the bony anatomy and the tumour to the mid-ventilation planning CT; 2) a couch correction was performed to align the tumour; 3) a 2nd CBCT ($CBCT^2$) was acquired to verify the correction prior to dose delivery; 4) following a non-coplanar IMRT technique or a dual arc VMAT technique, a 3rd CBCT ($CBCT^3$) scan was acquired. Intrafraction motion was evaluated between $CBCT^2$ and $CBCT^3$. Treatment time was calculated for both techniques and was defined as the difference in time between $CBCT^3$ and $CBCT^2$. The difference in intrafraction motion between the 2 techniques was analysed in terms of the group mean, systematic and random errors.